

March 7, 2001

MEMORANDUM FOR: Contract Geodetic Control Survey

FROM: Charles W. Challstrom
Director, National Geodetic Survey

SUBJECT: PROJECT INSTRUCTIONS for "Establishment of Geodetic Control on Airports" Survey in Alaska 2001

GENERAL:

Specifications for Area Navigation Approach (ANA) surveys to establish geodetic control, position runway end points and profile runways on airports are outlined below and in referenced documents. This survey will establish Primary and Secondary Airport Control Stations (PACS and SACS) at all airports and position runway end points/measure runway lengths at 5 of the 13 airports in Alaska listed in Attachment 1. The contractor is responsible for all airport permissions and clearances, reconnaissance, mark setting as required, digital mark descriptions and recovery notes, digital photographs, survey observations, data processing and adjustment, quality control, data submission, and reporting.

PURPOSE:

PACS and SACS will provide local geodetic control to support high-accuracy surveys of airport features and obstructions using both GPS and optical survey equipment. Ties to existing Continuously Operating Reference Stations (CORS), any Central Temporary Continuously Operating Reference Stations (CTCORS), bench marks, and High Accuracy Reference Network (HARN) stations will provide data for a more accurate adjustment to the National Spatial Reference System (NSRS). Runway profiles will aid in the development of better instrument approach procedures and better define the relationship between the geoid and ellipsoid in those specific areas of Alaska.

STANDARDS:

The required accuracy standards for PACS and SACS are listed below and are contained in FAA Number 405, "Standards for Aeronautical Surveys and Related Products", Fourth Edition, Appendix 5.

PACS - Accuracies are relative to the nearest NGS sanctioned CORS.

Horizontal	5 cm
Vertical (Ellipsoidal)	15 cm
Vertical (Orthometric)	25 cm

SACS - Accuracies are relative to the PACS and other SACS at the airport.

Horizontal	3 cm
Vertical (Ellipsoidal)	4 cm
Vertical (Orthometric)	5 cm

All accuracies are stated for a 95% confidence level.

Success in meeting accuracy standards will be based upon analysis of repeated baselines, loop misclosures, and free-adjustment residuals, and by comparison with prior high-accuracy surveys.

Third Order spirit level loop misclosures must check within $12\text{mm} \times (K)^{1/2}$ or better, where mm is millimeters and K is the distance of the level loop in kilometers.

SPECIFICATIONS:

In these Project Instructions and the accompanying General Specifications, Volume I., the terms "must," "shall," and "will," state a requirement. The term "should" indicates a recommendation.

This survey shall be conducted in compliance with standards and specifications within the following references. In the case of conflicting statements, these Project Instructions shall have first priority followed by the references in the order listed.

1. "FAA No. 405, Standards for Aeronautical Surveys and Related Products," 4th edition, FAA/NGS, September 1996. (abbr: FAA 405)
2. "General Specifications for Aeronautical Surveys, Volume I., Establishment of Geodetic Control on Airports," First Edition, NGS, June, 2000. (abbr: General Specifications, Vol. I.)
3. "Runway End, Stopway End, and Displaced Threshold Identification For Surveyors," First Edition, NGS, January 1, 1998. (abbr: Runway Manual)
4. "Input Formats and Specifications of the National Geodetic Survey Data Base,(with changes dated April 1, 1998)" FGCS, volumes I - III, 1994. (abbr: Blue Book)
5. "NOAA Manual NOS NGS 1, Geodetic Bench Marks," NGS, 1978. (abbr: BM Manual)
6. PAGES software, version 2000.09.07 (07SEP00); and "PAGE-NT USER'S MANUAL," NGS, September 2000. (abbr: PAGES Manual); also ADJUST

Software, Version "4.1," and other misc. checking software.

7. ADJUST Software, version 4.02; and NOAA Technical Memorandum NOS NGS-47, "ADJUST: THE HORIZONTAL OBSERVATION ADJUSTMENT PROGRAM," 1987.

8. WDDPROC Software, version 04.00.00 (20JUL00).

9. DOT/FAA Advisory Circular No. 150/5340-1G, "STANDARDS FOR AIRPORT MARKINGS," 1993.

10. DOT/FAA/AS-90-3, "A GUIDE TO GROUND VEHICLE OPERATIONS ON THE AIRPORT," 1990.

11. DOT/FAA Advisory Circular No. 150/5340-18C, "STANDARDS FOR AIRPORT SIGN SYSTEMS," 1991.

12. FGCC publication, Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques. Version 5.0, August, 1989, Appendix H.

RECONNAISSANCE INSTRUCTIONS:

Follow the Reconnaissance Requirements in Section 2 of the General Specifications, Vol. I. Reconnaissance will include meeting with airport management to discuss the project, any planned construction or changes to the airport, and all airport specific permissions and clearances. All suitable monuments on the airport will be recovered, including at least 2 local tidal bench marks at the 4 coastal airports in Deadhorse, Barrow, Elim and Nome. Suitable monuments are defined as a survey disk or similar type monument, meeting at least a stability code of "C", and considered suitable for GPS observations. Proper site selection for PACS and SACS is a primary goal for this survey and must be carefully considered. PACS and SACS selection guidelines are listed in Section 2.4 of the General Specifications, Vol. I.

Due to the lack of NGS vertical control in Alaska, the reconnaissance of NGS bench marks is critical. At least 12 bench marks will be recovered along the few established NGS leveling lines running from Prudhoe Bay to Anchorage and to the city of Boundary, AK to the east. These marks will serve as the vertical control for the eight airports along the west and north coasts to be surveyed during this project. Ideal general locations of bench marks to be used as control to provide the best overall distribution of the vertical datum are as follows:

2 ea -near the eastern edge of Alaska in the vicinity of Boundary, AK
 2 ea -in the vicinity of the town of Fairbanks
 2 ea -near the midway point between Fairbanks and Anchorage
 2 ea -in the vicinity of the town of Bettles
 2 ea -near the midway point between Bettles and Prudhoe Bay
 2 ea -in the vicinity of Prudhoe Bay

The following two paragraphs provide further guidance to Section 2.3 of the General Specifications, Vol. I. "Reconnaissance of Existing Marks:" "Full, three paragraph, NGS format station descriptions must be written for any suitable stations recovered during this survey that do not have an accurate description of this format in the NGS database. A listing of USC&GS, NGS, and NOS stations within 2.5 miles of each airport, and their respective descriptions will be provided by NGS. Stations set by other agencies may be used for PACS or SACS if they meet all requirements - See Section 2.4.5 of the General Specifications, Vol. I.

Stations recovered that are determined NOT to be suitable will be noted as such in the digital recovery note for that station. Full three paragraph descriptions and digital photographs are NOT required for these stations. A Recovery Note which states the reason the station is NOT suitable, the condition of the mark, and providing any updates to the "to reach" description is required.

A complete digital description file (D-file) from NGS programs within WDDPROC must be submitted with the final report. This description file shall include updated descriptions or recovery notes for all stations recovered during the project. The contractor will provide draft station descriptions as requested by NGS prior to project completion for quality control purposes.

MARK SETTING:

CTCORS, PACS and SACS:

Non-standard NGS marks will be used for all new stations. These marks are designed to best maintain vertical and horizontal integrity in the unique and ever changing environment of Alaska. These marks will be 2-3/8" diameter, Stainless Steel pipes of varying lengths (depending on depth of permafrost and availability of equipment) with flared bottoms and 3-1/4" NGS stamped brass caps. All new marks set should meet a stability code of at least "B" order (at least 10 feet deep), especially those to be used as CTCORS. The contractor will provide suggested mark-setting procedures to NGS, and NGS must approve the procedure before actually setting the marks. The NGS stamped caps will be provided to the contractor. The contractor will be responsible for assembly of the finished marks and purchase of all

other mark setting materials. The NGS stamped brass caps will be used for this project only. All unused brass caps will be returned to NGS upon completion of the project.

Runway End Points:

The contractor will identify, establish and position all runway end points. The runway end point positions will be determined using GPS survey methods and marked on the runway with a survey nail and NGS stamped washer, rebar or other semi-permanent types of survey marks per NGS RUNWAY MANUAL. Survey nails and NGS stamped washers will be used on paved runways (asphalt). NGS will supply the stamped washers. Rebar or other semi-permanent types of survey marks will be used on all other types of unpaved runways (gravel, dirt, etc.). The contractor will exercise care to ensure that the runway end point marks will not pose any safety hazards to aircraft or machinery expected to use or work on the runway. Where rebar or other semi-permanent types of survey marks are used, they should be set slightly recessed into the ground.

Runway end points will be designated as follows:

LID CL END RWY NN(T) where

- LID represents the FAA airport specific Location IDentifier
- CL represents the CenterLine of the runway,
- END represents the runway ENDpoint,
- RWY represents the abbreviation for RunWaY,
- NN(T) represents the runway Number and Type L, R, or C (left, right, or center) if applicable.

For example:

Runway 18 at Anchorage International Airport would be designated;

ANC CL END RWY 18

Runway 18 LEFT at Anchorage International Airport would be designated;

ANC CL END RWY 18L

PHOTOGRAPHS:

See Attachment 2 for digital photograph requirements.

DATA COLLECTION AND PROCESSING:

The nature of this project requires that all survey data be of the highest possible quality to ensure the safety of the National Airspace System.

Data collection shall be accomplished using FGCS approved GPS receivers (See General Specifications, Vol. I, Section 4.6). NGS software programs PAGES (vector reduction) and ADJUST (least squares adjustment) are required for final data processing.

Data collection shall utilize static GPS survey methods employing dual-frequency receivers. GPS data shall be collected at 15 OR 30 second epoch intervals, except as noted above, and converted to RINEX, version 2 format. Raw data shall be saved. Observing windows shall be selected, and modified as necessary, to maximize satellite visibility for each session.

Due to the limited number of established CORS sites in AK and the distances from the airports listed in Attachment 1, the use of CTCORS is required for this project. These CTCORS will provide the primary horizontal and vertical datum ties. Three CTCORS are required to provide control to the 8 coastal airports in Attachment 1. The other 5 "inland" airports will be tied to existing Alaska CORS sites and existing local NAVD88 bench marks where applicable. The three areas for the CTCORS are north coast, central west coast and southwest coast of Alaska.

CTCORS Area	City Name / LID
North Coast	Barrow / BRW
	Deadhorse / SCC
Central West Coast	Noatak / WTK
	Elim / ELI
	Nome / OME
Southwest Coast	Hooper Bay / HPB
	Kasigluk / Z09
	Bethel / BET

The CTCORS for these areas will be located on one of the airports in that area and will also serve as the PACS for that specific airport. The actual airport location of the CTCORS within the 3 different areas will be determined through discussions between NGS and the contractor dealing with security of survey equipment during extended observations, availability of mark setting equipment, and communication capability. If an existing NSRS mark is recovered on the airport and meets all stability and siting requirements for a PACS, then it may be used as the PACS for that airport and the CTCORS for that area. Otherwise, a new PACS will be set (SS pipe w/ cap) and serve as the PACS/CTCORS. All new marks set as CTCORS should be at least 10 feet in depth.

NAVD 88 Bench Mark, CTCORS and CORS Ties:

Vertical and horizontal datum ties will be established through co-observations of available CORS, at least 6 bench marks and all 3 CTCORS for at least 7 days CONTINUOUSLY (168 hours). The 6

additional recovered bench marks will be used as back ups.

PACS and SACS Ties:

All required observation times to establish PACS and SACS will be doubled for this project (ie. two 8-hour sessions PACS-CTCORS, two 3-hour sessions SACS-PACS). All other detailed recommendations and requirements for observing PACS and SACS are contained in these Project Instructions and the General Specifications, Vol. I.

Runway End Point Ties:

To establish runway end points, observe two independent GPS sessions at least 30-minutes long using the PACS as a base station and all receivers set to collect at a 5-second collection interval. Runway lengths are determined from the positions of the runway end points using NGS INVERSE3D software. Runway lengths will be computed while at the airport and compared to the lengths published in the Airport Facility Directory as applicable. If the computed length, rounded to the nearest foot, is shorter than the published length and the difference cannot be attributed to a runway change, review the points identified as the runway end points and contact NGS for further advice. This is especially important if the published length is a multiple of 500 feet.

Runway Profiles:

Runway profiles will be run at the airports in Noatak (WTK), Elim (ELI), Hooper Bay (HPB) and Kasigluk (Z09). Runway profiles will be obtained from Third Order spirit level loops running along the runway centerline. Profiles must begin on a runway end point, include three intermediate points, the other runway end point and then close the level loop back on the starting runway end point running back through the intermediate points. These points will be located along the runway centerline at approximately $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$ of the total length of the runway and marked with spray paint or any other temporary type of marking. Level loop misclosures will be calculated and should check within $12\text{mm} \times (K)^{1/2}$ or better, where mm is millimeters and K is the distance of the loop in kilometers.

The same three intermediate points described above will be positioned with GPS. Each of these intermediate points will be positioned by co-observing one session of at least 15 minutes with its respective PACS.

Local Tidal Bench Mark Ties:

At least two Local Tidal bench marks (if recovered in good condition) will be co-observed with their respective PACS for a minimum of one 2-hour session. These observations are the lowest priority.

Close contact with NGS prior to processing is recommended to address

the unique GPS networking involved in processing this project. It is highly recommended that the "SAVIT" files from the first several processing sessions be submitted to NGS for review prior to running the adjustment.

DATA SUBMISSION:

All survey data and reports shall be organized and submitted in accordance with the references above. Level data will be submitted in the form of field level books and final level results. The final level results will be a tabular summary of elevation differences between runway end points and all intermediate points with loop misclosures at each of the airports where runway profiles were run. All records for this project shall be archived under the title "Alaska Geodetic Control Survey, 2001". All computer-generated digital data files must be described and submitted to NGS in digital form on 100MB Zip Disk, or on other media approved by NGS at the time of submission.

REPORTS:

A draft reconnaissance report and survey plan shall be submitted to NGS for review prior to field observations. The purpose of this report is for NGS to approve/disapprove the stations selected for GPS observations. The preliminary reconnaissance information and survey plan can be submitted in rough format to facilitate efficient field operations. NGS will issue an approval/denial notice after reviewing the reconnaissance report. Progress reports and draft airport sketches (ie. a copy of the airport diagram depicting the location of the marks to be surveyed on the airport) shall be submitted to NGS on a weekly basis or as agreed upon with NGS; e-mail or fax is acceptable. A final project report and data, as described in the General Specifications, Vol. I., shall be submitted within 90 days of the completion of observations.

MATERIAL PROVIDED BY NGS:

All necessary software should be available from the NGS website or ftp address. See the General Specifications, Vol. I. for downloading information.

The following supporting material will be provided by NGS:

1. List of airports to be surveyed (Attachment 1).
2. Airport Master Record (FAA form 5010) and airport layout diagram for each airport listed in Attachment 1.
3. NSRS station descriptions for ANA suitable monuments

within 2.5 miles of each airport in Attachment 1 (digital copy).

4. NOS station descriptions for tidal bench marks in Prudhoe Bay, Barrow, Elim and Nome (hard copy).
5. References 1 - 12.
6. Mark Setting materials as listed.

The 3-1/4" NGS stamped brass caps will be provided to the contractor. The contractor will be responsible for assembly of the finished marks according to the manufacturer's recommendation and purchase of all other mark setting materials.

The NGS stamped washers (for runway end points) will be provided to the contractor.

MONITORING:

NGS may assign personnel to observe the survey field work in progress for quality and conformance to specifications. NGS may request a meeting with the contractor prior to and/or during field operations to meet with project personnel, inspect survey equipment, and discuss any issues that need clarification.

LIAISON:

The contact point for all NGS supplied material, inquiries, and for submission of data, reports, sketches, etc. is:

LT Todd A. Haupt, NOAA
ATTN: N/NGS41; SSMC3, Station 8610
1315 East-West Highway, Silver Spring, MD 20910-3282
PHONE: (301) 713-1054
FAX: (301) 713-4315
E-mail: Todd.A.Haupt@noaa.gov and
cc Libby.Wade@noaa.gov

The contractor will coordinate all surveying activities with the State Aviation Official for Alaska via NGS. The contractor shall give advanced notice of their survey schedule to the appropriate local airport officials.

ACKNOWLEDGEMENT:

Please acknowledge receipt of these instructions.

cc:	NGS4	Wade	
	NGS41	McLemore	
	NGS41	Haupt	
	NGS2	McKay	
	NGS21	Frakes	
	NGS1	Mitchell	
	USACE, Mobile District		Mike Nettles
	R&M, Consultants, Inc		Len Story